Biotelemetry Lab

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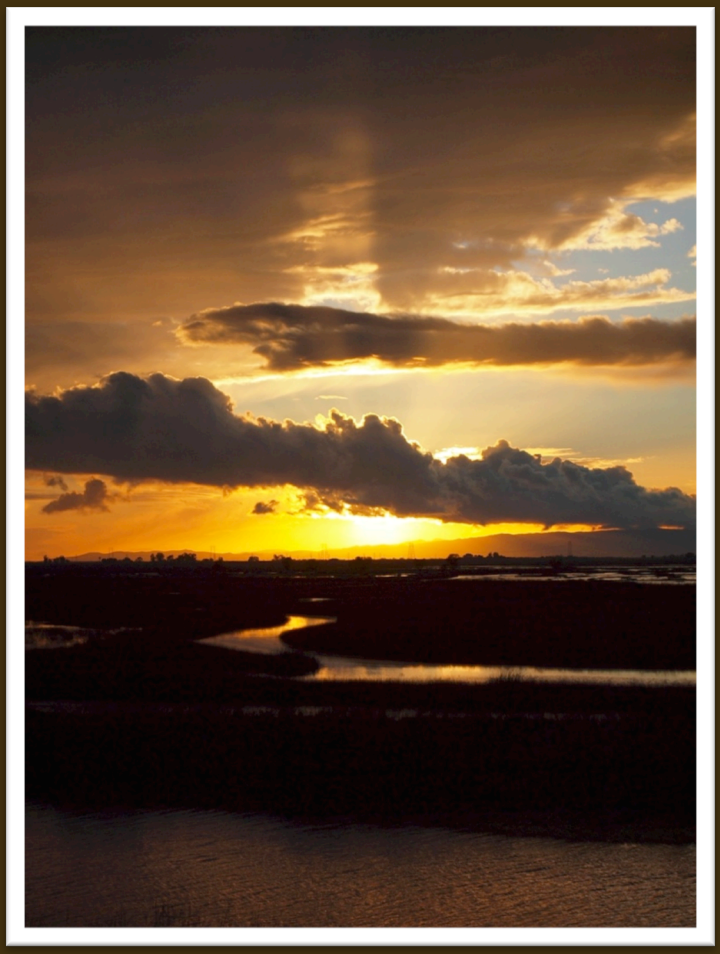
# Yolo Bypass Project

## Telemetry Task (4.3)

## 2012 Annual Report



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# Executive Summary

We are in the final year of the telemetry tasks for the Yolo Bypass Project. The table below summarizes the fish we have tagged and have monitored or are currently monitoring in the system:

| Species | Number Tagged | Date(s) Tagged | Tag Life |
|---|---|---|---|
| *White sturgeon (Acipenser transmontanus)* | 68 | March 16-23, 2012 | ~10 years |
| *Adult Chinook salmon (Oncorhynchus tshawytscha)* | 12 | October 24 – November 27, 2012 | 90 days |
| *Juvenile Chinook salmon (Oncorhynchus tshawytscha)* | 25 | March 29, 2012 | 22 days |
| *Juvenile Chinook salmon (Oncorhynchus tshawytscha)* | 25 | March 6, 2013 | 63 days |

Detections are available from March 2012 – May 2012 and October 2012 – February 2013. This dataset includes the first release of Juvenile Chinook, and adult Chinook and white sturgeon movements within those times.

With this dataset, we have estimated values for juvenile Chinook survival (first release), adult white sturgeon residence time, and transit time and migration route selection for the 12 adult Chinook salmon. These data are reported in the sections below. Also reported are planned analyses and future explorations before the telemetry portion of the project ends in February 2014.

# Note

All calculations and statistics reported here are the results of preliminary, on-going analyses. As a first year graduate student, I have a great deal to learn (in terms of material, models, and statistical methods) before I will be completely confident in my estimates.

## Hypotheses

Beyond a general description of the timing and occurrence of large numbers of migrating Chinook salmon, sturgeon, splittail, striped bass (Harrell and Sommer 2003; BDCP 2010), remarkably little is known about what happens to these fishes once they enter Yolo Bypass. As a result, the working hypothesis for the Yolo Bypass Project is broad in nature:

- Residence time and spatial use in the Yolo Bypass of both juvenile and adult migratory species will vary under different hydrological conditions (dry vs. flooded, for example)

Some of the obvious questions that need to be answered to test this hypothesis and identify specific challenges to fish passage in the Bypass include the following:

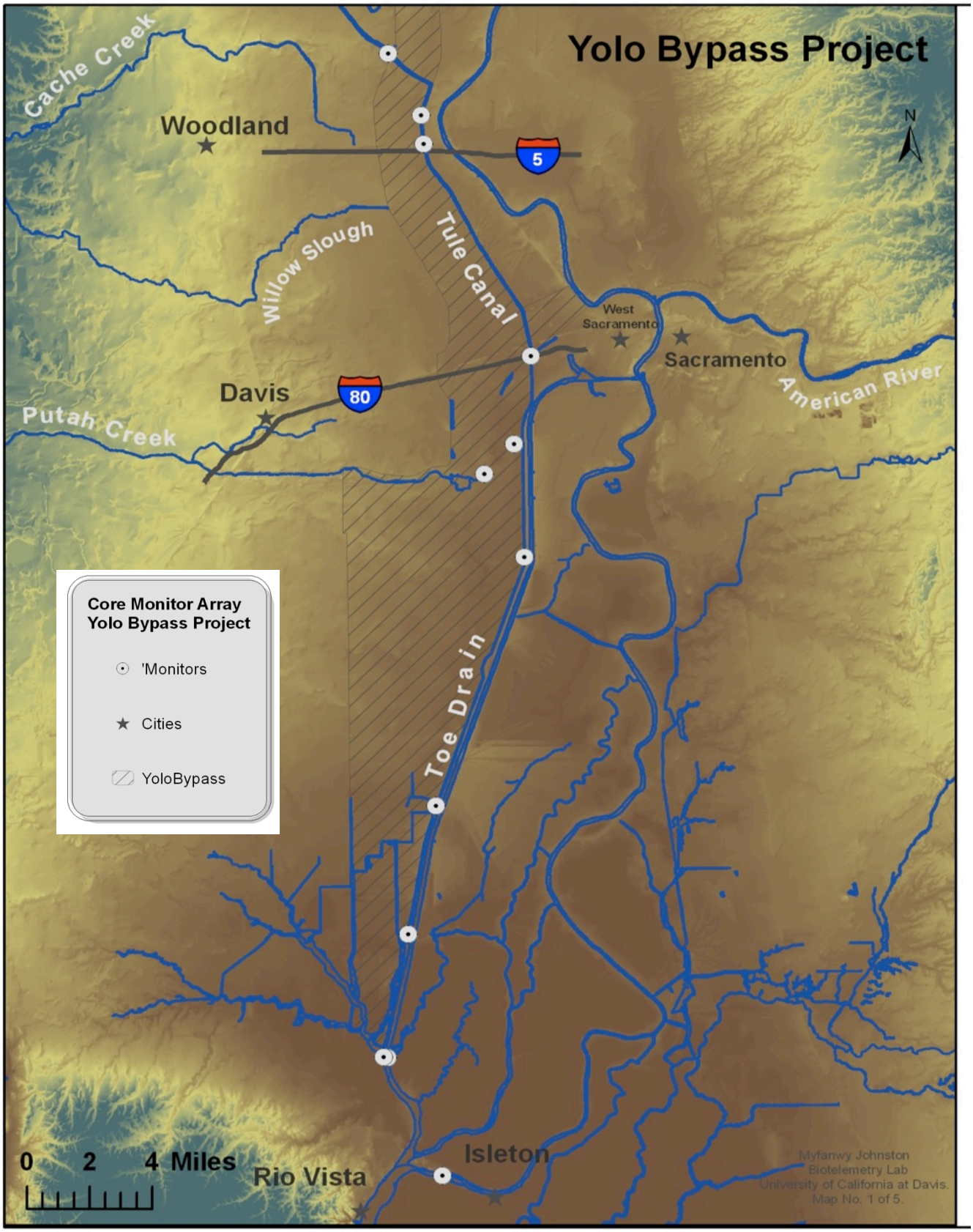
- What is the residence time of migratory fishes (white sturgeon, Chinook salmon) in Yolo Bypass?
- Where do adult fish move to within the floodplain under different conditions?
- What factors influence juvenile survival in the floodplain?
- Are there specific areas of the floodplain where there is evidence of increased mortality, stress or holding behavior?

We are in the beginning stages of addressing parts of these questions through the acoustic telemetry task.

# DATA

## Acoustic Receiver Arrays

We maintain two separate arrays of Vemco VR2W receivers in the Yolo Bypass: 69khz and 180khz. The number of deployed receivers depends on the conditions present in the Bypass (flooded or dry). The map on the following page depicts our core array of receivers (both 69khz and 180khz) under dry conditions. Under flood conditions, more receivers are placed in the Bypass across I-80 and at the confluence of the deep water shipping channel and the Toe Drain.


Yolo Bypass Project
Cache Creek
Woodland
5
Willow Slough
Tule Canal
West Sacramento
Sacramento
American River
Davis
80
Putah Creek
Core Monitor Array
Yolo Bypass Project
'Monitors
Cities
YoloBypass
Toe Drain
0 2 4 Miles
Rio Vista
Isleton
N
Myfanwy Johnston
Biotelemetry Lab
University of California at Davis.
Map No. 1 of 5.

# Tagging Summaries

### Juvenile Chinook, first release (25 Fish, tagged 3/29/12)

| Fork Length Range (mm) | Mean Fork Length (mm) | Weight Range (g) | Mean Weight (g) |
|---|---|---|---|
| 107 - 145 | 126.5 | 12.00 – 32.14 | 22.28 |

### Juvenile Chinook, second release (25 Fish, Tagged 3/5/13)

| Fork Length Range (mm) | Mean Fork Length (mm) | Weight Range (g) | Mean Weight (g) |
|---|---|---|---|
| 107 - 125 | 116 | 12.60 – 23.00 | 17.06 |

### Adult white sturgeon (68 Fish, Tagged 3/16/12 – 3/23/12)

| Fork Length Range (cm) | Mean Fork Length (cm) | Known Males | Known Females | Sex Unknown |
|---|---|---|---|---|
| 96 - 190 | 146.2 | 42 | 4 | 21 |

### Adult Chinook salmon (12 Fish, Tagged 10/24/12 – 11/27/12)

| Fork Length Range (cm) | Mean Fork Length (cm) | Known Males | Known Females | Sex Unknown |
|---|---|---|---|---|
| 59.5 - 84 | 74.86 | 3 | 8 | 1 |

White sturgeon were implanted with Vemco V16 tags, adult Chinook salmon were externally tagged with Vemco V9 tags, and juvenile Chinook were implanted with Vemco V5 tags. All tagging procedures went very smoothly. To complete the Telemetry Task, we plan to tag 25 adult Chinook in the fall of 2013, and 50 Chinook smolts in winter of 2013.

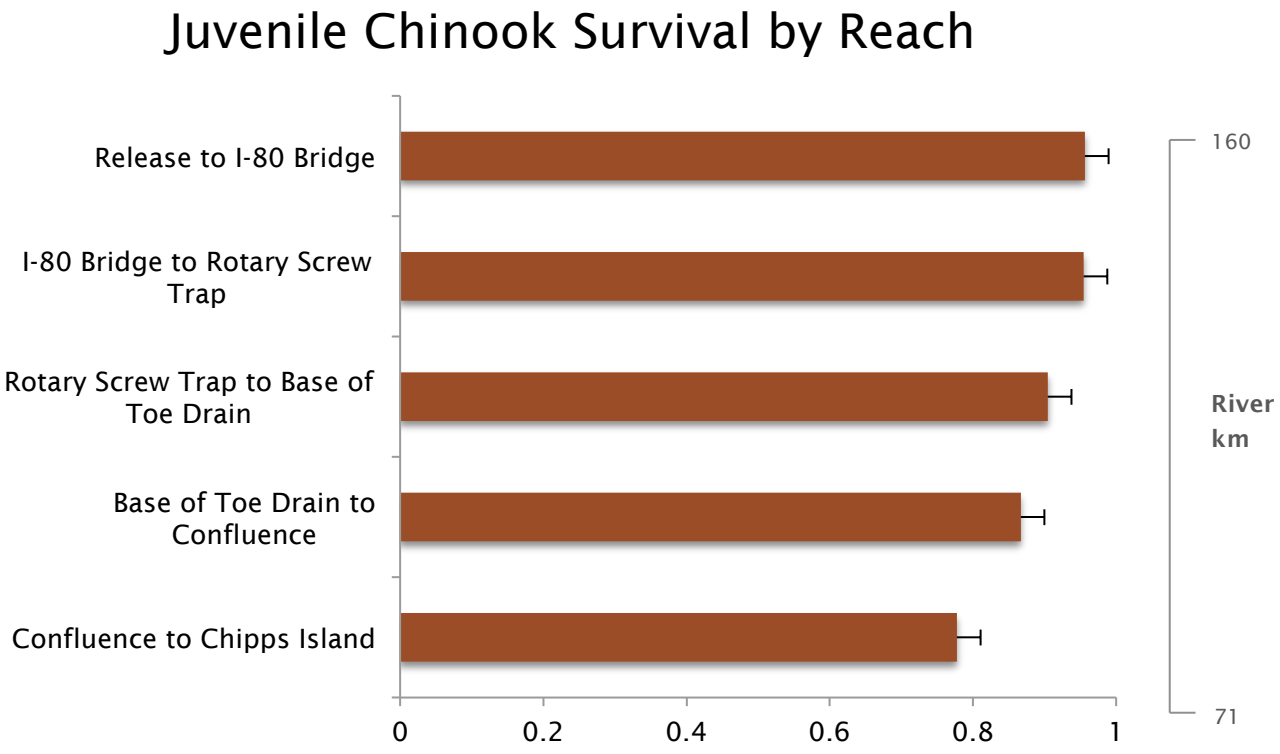
# RESULTS

## Juvenile Chinook Survival

The reaches analyzed, in order of succession, were the release site to I-80 Bridge, I-80 Bridge to the rotary screw trap maintained by the Department of Water Resources, the rotary screw trap to the base of the Toe Drain, the base of the Toe Drain to the confluence of the Toe Drain and the deep water shipping channel, and the confluence to Chipps Island. The river kilometers and detection probabilities for these sites are summarized in the table below.

| Site | River Kilometer | Detection Probability |
|---|---|---|
| Release Site (Cache Creek) | 159 | 0.92 |
| I-80 Bridge | 146 | 0.91 |
| Rotary Screw Trap | 120 | 0.90 |
| Base of the Toe Drain | 113 | 0.68 |
| Confluence | 106 | 0.93 |
| Chipps Island | 71 | 0.92 |

Survival estimates were calculated using a mark-recapture maximum likelihood estimators for CJS models, adapted from Seber et al. 1982 (pg 200) and Burnham et al. 1987 (pg 114). Error bars represent the Standard Error of the probability that the fish detected at site *i* was also detected at site *i* -1.




Juvenile Chinook survival in the Toe Drain (total reach: 52.83km) was high: 0.87 (0.06 +/- SE). Survival from the release site in the Bypass to Chipps Island (19 river kilometers upstream of the Benecia-Martinez Bridge) (total distance: 89 river kilometers) was slightly lower, at 0.78 (0.07 +/- SE). We will be comparing this to the survival of the second release of Chinook smolts after the second release's tag lives have expired (June 2013).

## Juvenile Chinook Transit Time

Average transit time from the release site to Chipps Island was 11.23km/day (3.24 +/- SD).

| Reach | Distance (km) | Sample Size | Mean (km/day) | Standard Deviation (km/day) | Mean (km/hr) | Standard Deviation (km/hr) |
|---|---|---|---|---|---|---|
| Release Site to Rotary Screw Trap | 8.39 | 21 | 17.35 | 0.72 | 7.56 | 0.32 |
| Rotary Screw Trap to Base of the Toe Drain | 7.23 | 15 | 20.88 | 15.56 | 0.87 | 0.64 |
| Base of the Toe Drain to the Confluence | 7.21 | 11 | 10.44 | 8.44 | 0.44 | 0.35 |
| Confluence to Chipps Island | 35.5 | 14 | 15.36 | 4.90 | 0.64 | 0.20 |
| Release Site to Chipps Island | 88.33 | 13 | 11.23 | 3.24 | 0.47 | 0.13 |

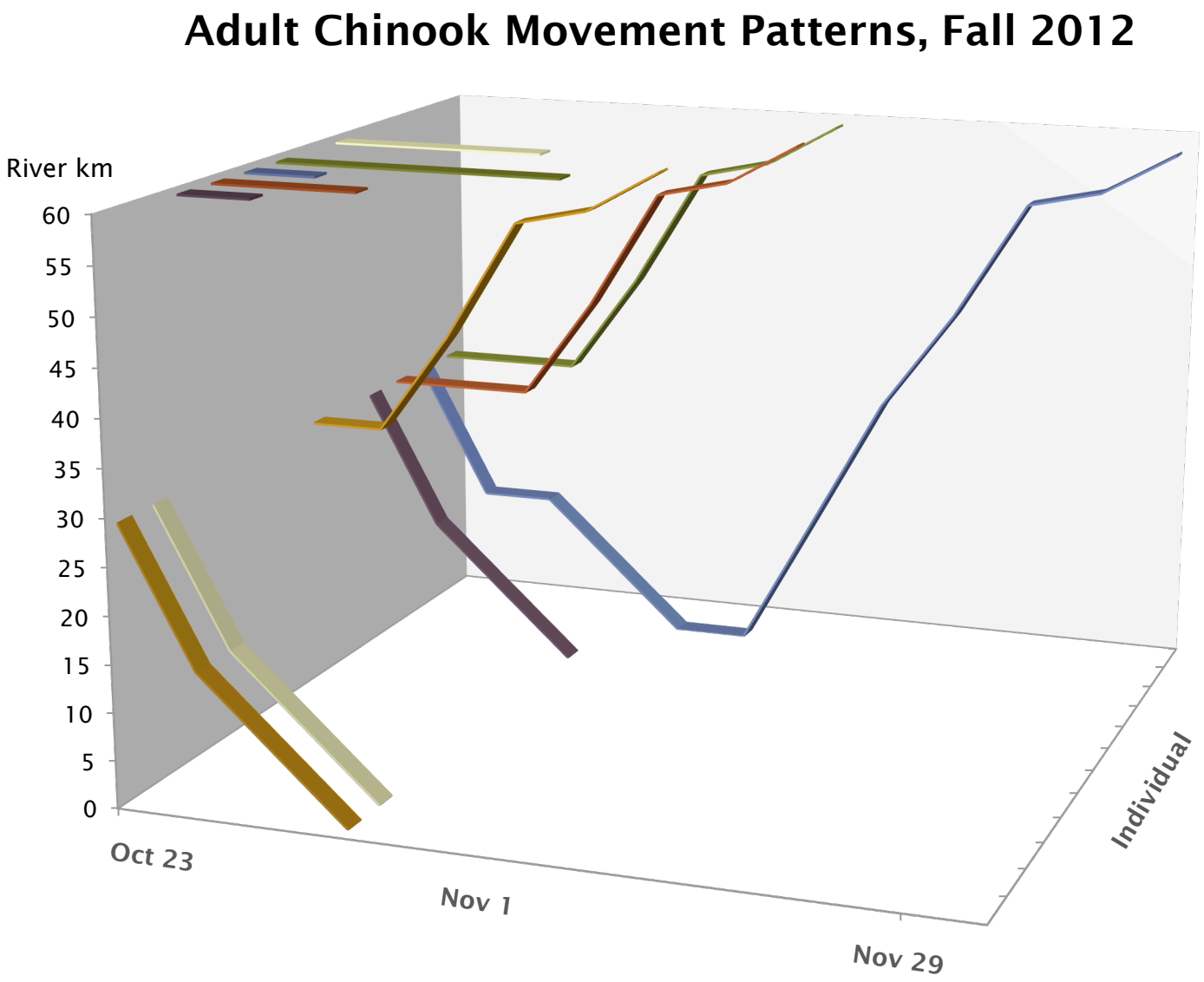
We will be comparing these first Chinook release transit times to the second release once we obtain the detection files from currently deployed monitors.

# Adult Chinook Movement Patterns

Twelve adult migrating Chinook salmon were caught and tagged in the Toe Drain: five at the upper reach of the monitor array, at Wallace Weir (river km 165), and seven lower down in the Toe Drain at Lisbon Weir and the Fyke Net (river km 135). The adult salmon reaches are different from the juvenile salmon reaches, as we considered their exiting the system when they reached the confluence of the Toe Drain and the deep-water shipping channel, a total distance of 59.14 kilometers. The table below summarizes the receiver sites, and displays corresponding river kilometers:

| Site | River Kilometer |
|---|---|
| Confluence | 0 |
| Base of Toe Drain | 7.21 |
| Rotary Screw Trap | 14.44 |
| Lisbon Weir | 29 |
| I-80 Bridge | 39.84 |
| Cache Creek | 52.83 |
| Knagg's Ranch | 54.59 |
| Wallace Weir | 59.14 |

Adult Chinook movement tracks are shown below in three dimensions – the vertical axis is river kilometer, the horizontal axis is time, and the third (z) axis shows movement in space. Each colored bar represents the track of an individual fish – the track begins at the date the fish was tagged and ends at the date the fish was last detected. Representing the data this way allows for interpreting whether a fish was last seen moving upstream or downstream.



## White Sturgeon Residence Time

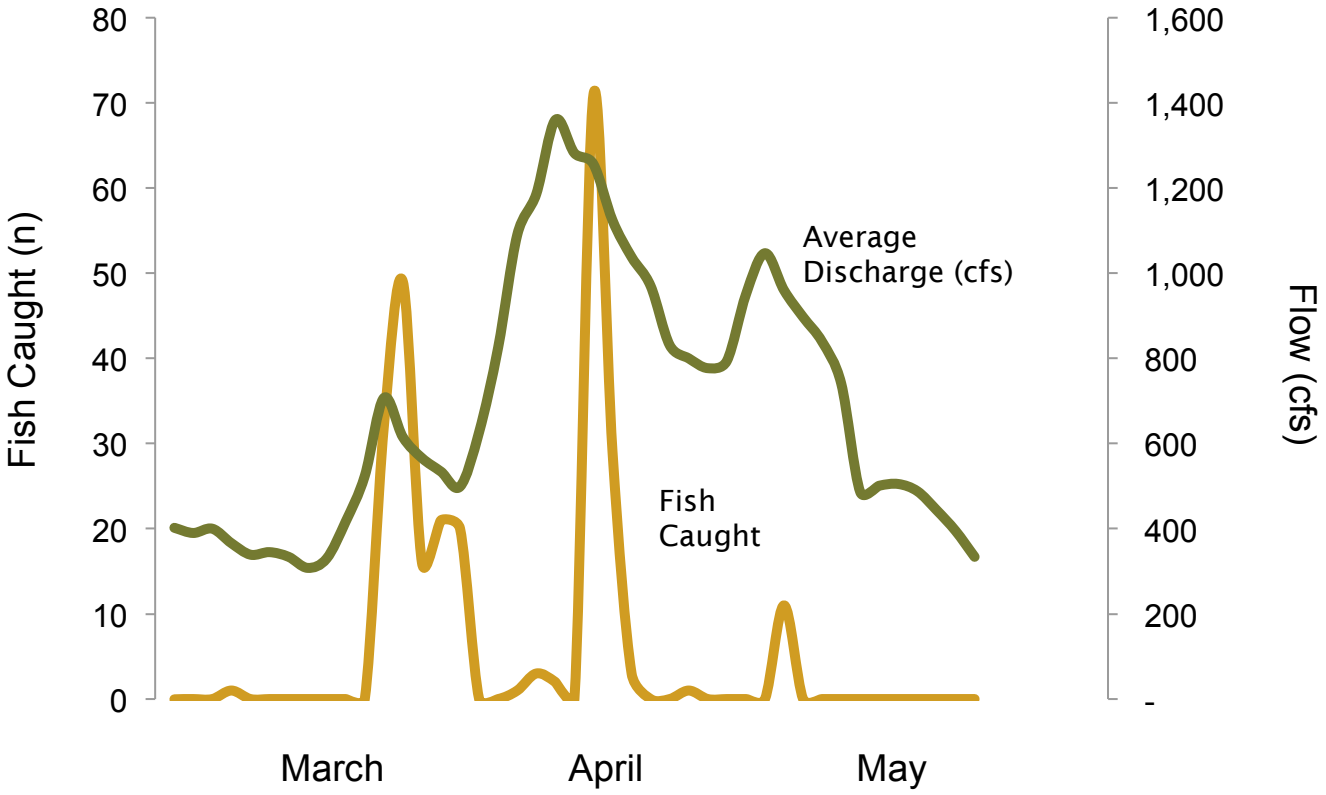
The 68 tagged adult white sturgeon were monitored from Knagg's Ranch (in the northern extent of the Yolo Bypass, river km 160) to the Confluence of the Toe Drain and the deep-water shipping canal. A fish was considered to have exited the system when their final detection was at the Confluence. The following boxplot summarizes average residence time (in days) according to sex.


Average individual residence time in the Yolo Bypass was 19 days (2.94+/- SE).

## Examining Relationships Between Movement and Flow

There is a distinct pattern in catch records and pulse-flow events – a peak in catch followed a pulse-flow from March through May. We hope to examine the relationship between pulse flow events and white sturgeon movements in the Bypass further in the coming year.

White Sturgeon caught in Fyke net and average flow discharge in the Bypass



# Conclusions

It is difficult to draw any conclusions halfway through the study and at this early stage of the analysis. We have demonstrated the efficacy of telemetry in the Yolo Bypass, and look forward to the next stages of the project.

# Recommendations: Future Analyses

The past year has seen very dry conditions in the Bypass. This has helped our detection probabilities, but has hindered our ability to compare fish movement and residency behavior under different environmental conditions. We are still hoping to observe juvenile and adult movement behavior in the Bypass under flooded conditions.

It was very difficult to capture adult migrating Chinook salmon, and thus the sample size was small this year. We have plans to improve our capture efficiency and tag the full sample size of 25 individuals this fall. Additionally, we will be examining detection histories of our fish from the 300 receivers maintained in the area surrounding the Yolo Bypass by the California Fish Tracking Consortium. This will allow us to complete individual fish tracks with all available detections, and to examine mortality in the system, especially for the adult Chinook last detected at Wallace Weir (the northern extent of our study area).

Future explorations and analyses will include:

- Tag-survival probability
- Habitat characterization of the Toe Drain and the areas of the Yolo Bypass that become inundated during flood events.
- Group movements – arrivals and departures at monitors in groups
- Mortality assessment – identifying areas of increased holding or stranding.

## References

Burnham, K. P., D. R. Anderson, G. C. White, C. Brownie, and K. H. Pollock. 1987. Design and Analysis Methods for Fish Survival Experiments Based on Release-Recapture, American Fisheries Society Monograph 5, Bethesda, Maryland.

Seber, G.A.F. 1982. The estimation of animal abundance and related parameters. The Blackwell Press, Caldwell, New Jersey